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Long term grazing management studies must cover both wet and dry phases of the climatic cycle in order to provide reliable estimates of the effects of various grazing management practices on livestock production and on the range resource. Intensity of grazing studies with sheep have been conducted at the Antelope Range since 1950. A progress report of this work was published by Gartner, Lewis and Trevillyan (1965). The first phase of this study was concluded in 1962.

The Study Area

The Antelope Range is located approximately 15 miles east of Buffalo in Harding County in the lowest precipitation zone in the state. Annual precipitation for the period of record from March, 1953 through November, 1969 has averaged 13.57 inches. Warm season (June, July, August) cool season (previous September through current May) and vegetation year (previous September through current August) precipitation and their departures for the period 1962 through 1969 are shown in table 1. For the eight years 1954 through 1961, vegetation year precipitation averaged 11.94 inches with an average departure of -1.63 and a total departure of -13.02 inches. During this 8 year period one year was about average (1956 with 13.75 inches), one was above normal (1957 with 15.25 inches) the rest were below normal. The four years 1958 through 1961 were especially dry with only 9.92 inches of precipitation falling during the 1961 vegetation year. However, during the eight year period since 1961 (table 1) the vegetation year precipitation has averaged 15.62 inches with an average departure of +2.05 inches and a total departure of +16.42 inches. Two years during this period were slightly below normal. Thus, the data reported are from a different phase of the climatic cycle than that reported earlier.

The vegetation at the Antelope Range is the northern mixed prairie type. The dominant cool-season grasses are western wheatgrass (*Agropyron smithii*) and needle-and-thread (*Stipa comata*): the dominant warm-season grass is blue grama (*Bouteloua gracilis*). Other common grasses are green needlegrass (*Stipa viridula*), prairie sandreed (*Calamovilfa longifolia*), prairie junegrass (*Koeleria cristata*), little bluestem (*Andropogon scoparius*) and bluegrasses (*Poa* spp.). Sedges, especially threadleaf sedge (*Carex filifolia*) and needleleaf sedge (*Carex eleocharis*), are fairly abundant. Silver sagebrush (*Artemisia cana*), is conspicuous as are many native forbs.

Soils in this dry part of the Chestnut soil zone have not been leached to any great depth. Consequently, lime and other carbonates have accumulated fairly high in the soil profile. Most of the soils on the field station have fine sand incorporated in their surface horizons. The majority of these soils would be classed as a silty range soil group. Other important range-soil groups found on the station are sandy, thin silty, thin sandy, claypan, thin claypan, and overflow.

Procedure

In the fall of 1962, 400 range ewes aged two through six the following spring were permanently allotted by restricted randomization to four summer grazing treatments and within each grazing treatment ewes were allotted each year to different lambing treatments. The summer grazing treatments were continuous season-long grazing at a light (<35%), medium (45-55%) or heavy (>60%) use rate from early May to late October. One hundred ewes were grazed at the medium rate under a four-pasture rest rotation grazing system in which season of use was rotated on the grazed units. One pasture was rested each year. Time of movement was based on utilization. Put-and-take ewes were used to adjust the stocking rate to secure the desired degree of use. Ewes were winter-grazed as a band on deferred range and fed 2/3 lb. of 40% protein supplement containing added phosphorus and vitamin A every other day until approximately 6 weeks before lambing and then were given the same amount of supplement daily until lambing. Iodized salt was provided. Prairie hay was fed at the rate of about 3 3/4 lbs. per head daily when snow cover prevented grazing. Ewes were sheared approximately 3 weeks to one month before the beginning of lambing. Ewes were bred to Hampshire rams to begin lambing about April 1 in 1964 and 1965 and about April 15 in subsequent years. Ewes were treated with thiobenzole for internal parasites about November 1 each year. Ewes were shed-lambed, kept in lambing jugs 1 to 2 days and in doubling up pens 1 to 2 weeks before turning out on spring range.

From 1964 through 1967 half of the ewes in each grazing treatment were fed prairie hay plus 2/3 lb. 40% protein supplement from the time they lambed until they left the lambing pens. Prairie hay was fed alone until the new grass was abundant enough that they quit coming for hay. The other half of the ewes were self-fed a pellet containing approximately 2/3 prairie hay and 1/3 barley with 5% molasses. In 1968 and 1969 the treated ewes were hand-fed a lambing ration of about 2 lb. prairie hay, 1 lb. alfalfa and 2 lb. barley while in the lambing pens and 1 lb. barley and 2 lb. alfalfa from the time they left the lambing pens until placed on summer pasture. Results of the lambing ration studies 1964-66 were reported by Lewis and Trevillyan (1967).

Results and Discussion

Year Differences

From the standpoint of forage production all of the years from 1964 through 1969 were very favorable. Although precipitation for the vegetation year was below normal in 1967 and 1968 (table 1) rains were well distributed, there was an abundance of old growth, and the grass made considerable re-

growth after grazing under all treatments. Consequently, all available put-and-take ewes were used and others were brought from Newell each year. Nevertheless in most years utilization levels were below that which was planned.

In 1964 weather after lambing was very favorable, grass came early and lambs did well. However, an epidemic of dog ticks (Dermicentra andersonii) occurred during late April and large lamb losses occurred especially in twin lambs. Post-mortem examination showed arthritis with increase in joint fluid from which staphylocci were cultured. One lamb was found to have multiple abscesses throughout the skeletal muscles and viscera from which staphylocci were cultured. These organisms may have entered through the tick bites. Lambs that recovered grew slowly and weaning weights were low in all lots (tables 2, 4, 5).

In 1965, the ewes were in very good condition and the lambs got off to a good start. However, spring storms occurred at about weekly intervals during April. Approximately 12 inches of snow and a total precipitation of 2.65 inches were received in April. Lamb losses were high especially with twins suckling ewes not receiving a special lambing ration. Cool season precipitation was 5.15 inches above normal and needle-and-thread made an abundant crop of needles, especially in the lightly and moderately grazed pastures. Needle injury appeared to reduce weaning weights in these pastures (tables 4 and 5).

In 1966, a severe blizzard occurred on March 3 and dropped about 13 inches of snow in 2 days. A number of ewes were lost in drifts. However, the ewes were very strong and thrifty and those that were found and dug out within 5 days were still alive and healthy. However, ewe losses averaged 12% (table 2). Lambing did not begin until April 12 and lambs had very little climatic stress after being turned out on spring range.

In 1967 a severe blizzard struck on April 30 and dropped about 2 feet of snow in less than 36 hours, winds up to 70 miles per hour caused tremendous drifts and buried many ewes and lambs. Ewe death losses averaged 11% for the year and lamb losses were very high in all treatments (table 2, 4, and 5). The lambing ration study was discontinued and all ewes were fed prairie hay free choice and 40% protein supplement until the snow melted and grass was available. The summer was quite dry. However, weaning weights were near normal (table 2).

Although, precipitation was slightly below normal in 1968 especially early in the season, subsequent rains were well distributed, regrowth was vigorous, forage quality was excellent and was reflected in excellent lamb survival and high weaning weights in all pastures (table 4 and 5). Precipitation was very favorable early in 1969 but the weather was very dry in late summer. Weaning weights were about normal.

Grazing Management

For the six years stocking rates averaged 0.23, 0.32 and 0.52 AUMs/acre respectively for light, medium and heavy grazing (table 3). This corresponds to 0.87, 0.62 and 0.38 acres per ewe per month. During these favorable years the maximum change in stocking rate from low to high amounted to a 24% increase in light grazing, 32% in moderate continuous, 23% in heavy and 28% in moderate rest rotation. These stocking rate increases in most years were not sufficient to secure the planned utilization rates. The heavily grazed pasture exceeded full use in only two years, 1964 and 1966.

Utilization is very difficult to measure in these pastures because of very spotty grazing. Areas near the bedground, water, loafing areas and areas previously grazed are grazed repeatedly to very low stubble heights. Other areas may remain completely unutilized. Increasing the stocking rate results in a reduction of ice cream plants and an increase in the acreage that is closely utilized. In light grazing some areas are very closely utilized year after year. In heavy grazing many areas have remained unused since the drought of 1961 when the pasture was severely utilized. Ice cream plants, especially palatable browse such as American plum, buffaloberry, western snowberry and silver sagebrush have been killed in moderate and heavy continuous grazing but still remain in light grazing.

In the rest rotation grazing system with a rotation of season of use on the grazed units, these plants are increasing where remnants existed when the system was begun. While the grazing system helps to protect preferred species it does not solve the spotty grazing problem. It appears that common use of grazing by more than one kind of grazing animal will be needed to improve distribution on ranges similar to those at the Antelope Range. The rest rotation grazing system has resulted in somewhat lower utilization at the same stocking rates. Range condition has improved markedly. However, the rest rotation grazing system with rotation of season of use on the grazed units has resulted in poorer ewe condition in the fall, lower lamb crop born, lower weaning weights of single and twin lambs, and less lambs weaned per ewe bred than any of the other lots (table 3). This was true in most years (tables 4 and 5). The lower performance of the ewes on the grazing system is probably related to the reduction in the amount of regrowth which can be utilized thus forcing the sheep to consume more mature forage which is somewhat lower in nutritional value. Diet studies are needed using esophageal fistulated ewes to clarify this point. Probably, higher livestock production per head can be obtained by omitting the rotation of season of use on the grazed units. This would probably be desirable on ranges that are in high range condition. However, as ranges are in low range condition, the rotation of season of use will hasten improvement.

In marked contrast to the earlier studies conducted during the dry phase from 1953-1961 (see Gartner, Lewis and Trevillyan, 1965) the ewes in the heavily grazed pasture were about as productive as those in the light or medium pastures. This was probably due to the very favorable precipitation which increased forage production and permitted extensive

use of regrowth. Range condiiton is continuing to decline in favored areas some of which are now in poor+ range condition. However, there are areas in the pasture which are in excellent range condition. In general, however, palatable forbs and browse are completely or nearly absent and palatable midgrasses such as green needlegrass and western wheatgrass are being replaced by blue grama and buffalograss except in ungrazed areas. Big bluestem is taking extreme grazing pressure but is still persisting in some drainageways. Plains pricklypear appears to be increasing. Some accelerated erosion by wind and water is evident on the closely utilized areas. A return to the dry phase of the climatic cycle will undoubtedly result in a drastic change in plane of nutrition and in ewe production from this pasture.

Complete economic analysis of this study is not possible at this time. If the cost of returning the heavily grazed pasture to excellent range condition is ignored, heavy use will be the most economical management practice during the wet phase of the climatic cycle. However, range improvement costs must be considered in the long run and when these are included this type of use is not very attractive, especially during the dry phase of the climatic cycle.

Summary and Conclusions

A long term grazing management study comparing light, moderate and heavy continuous grazing and a moderate rest rotation grazing system with ewes at the Antelope Range is being continued during a wet phase of the climatic cycle. Year differences due to blizzards, spring storms, precipitation and disease have been of overriding importance in sheep production regardless of treatment. Contrary to results obtained during a dry phase of the climatic cycle, ewe performance under heavy grazing has been approximately equal to that of ewes on lightly and moderately grazed pastures. Range deterioration, however, continues on closely and severely used portions of the pasture. Rest rotation grazing with a rotation of season of use on the grazed units has resulted in good range improvement and lower degrees of utilization at the same stocking rate. However, ewe and lamb production has been lower than from any other treatment. This study is planned to continue into the dry phase of the climatic cycle with modifications that will include common use grazing by sheep and cattle, removing the rotation of season of use from the rest rotation grazing system, and hopefully including studies to measure the actual intake and nutritional value of the diet of grazing cattle and sheep.

Literature Cited

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Table 1. Warm season, cool season, and vegetation year precipitation and departures at Antelope Range, 1962 through 1969.

	Year								
	1962	1963	1964	1965	1966	1967	1968	1969	Mean
Warm season[1], inches	3.04	11.43	10.40	6.08	8.37	5.04	7.09	9.03	7.56
Departure[1], inches	-3.83	+4.56	+3.53	-0.79	+1.50	-1.83	+0.22	+2.16	+0.69
Cool season[2], inches	12.25	8.35	5.74	11.85	5.46	7.48	5.98	7.39	8.06
Departure[2] inches	+5.55	+1.65	-0.96	+5.15	-1.24	+0.78	-.072	+0.69	+1.36
Vegetation year[3], inches	15.29	19.78	16.14	17.93	13.83	12.52	13.07	16.42	15.62
Departure[3], inches	+1.72	+6.21	+2.57	+4.36	+0.26	-1.05	-.50	+2.85	+2.05
Cumulative departure since 1961, inches	+1.72	+7.93	+10.50	+14.86	+15.12	+14.07	+13.57	+16.42	

1 Warm season precipitation is the precipitation received in June, July and August of the current year. Departures were calculated from the 17 year mean 1953 through 1969 of 6.87 inches.

2 Cool season precipitation is precipitation received from September of the previous year through May of the current year. Departures were calculated from the 17 year monthly means except that 16 year means were used for December, January and February. The mean value for this record was 6.70 inches.

3 Vegetation year precipitation is the sum of the warm season and the cool season precipitation or that received from September 1 of the previous year through August 31 of the current year. Departures were calculated from the mean value of 13.57 inches.

Table 2. Stocking rate, ewe death loss, fleece and lamb production, mean of all treatments by years. Antelope Range 1964 through 1969.

Years	1964	1965	1966	1967	1968	1969
Stocking rate, AUMs/a	.32	.37	.34	.31	.37	.35
Ewe death loss, %	6	6	12	11	5	3
Lambs born alive, % ewes bred	115	120	105	115	130	122
Lambs weaned, % ewes bred	82	84	96	71	117	96
Weaning weight singles, lb.	73	76	84	82	94	82
Weaning weight twins, lb.[1]	59	60	69	65	76	68
Lamb weaned lb./ewe bred[2]	57	58	75	55	99	73
Fleece wt., grease, lb.	8.6	9.4	9.0	9.2	10.5	

[1]Weaning weight of twins raised as twins.
[2]Includes weights of twins raised as singles, triplets raised as twins or singles and bums.

Table 3. Stocking rate, degree of use, range condition, ewe death loss, fleece and lamb production as affected by grazing treatments. Antelope Range. Six year means, 1964 through 1969.

Grazing system	Continuous			Rest Rotation
Grazing rate	Light	Moderate	Heavy	Moderate
Stocking rate, AUMs/a	.23	.32	.52	.32
Degree of use	Slight	Mod.-Full	Full-Close	Moderate
Range condition	Excellent	Good	Fair	Good+
Ewe death loss, %	8	6	8	7
Lambs born, % ewes bred	121	121	116	113
Lambs weaned, % ewes bred	88	92	93	91
Weaning weight, singles, lb.	85	81	82	79
Weaning weight, twins, lb.	68	68	67	63
Lamb weaned, lb/ewe bred	69	71	71	66
Fleece weight, grease, lb.	9.4	9.8	9.2	9.0

Table 4. Stocking rate, degree of use, ewe death loss, fleece and lamb production by years in the light and moderate continuously grazed pastures. Antelope Range, 1964-69.

Grazing rate	Light							Moderate						
Year	64	65	66	67	68	69	All years	64	65	66	67	68	69	All years
Stocking rate, AUMs/acre	.23	.24	.22	.21	.26	.24	.23	.29	.34	.30	.28	.37	.32	.32
Degree of use	Sl*	Sl*	Sl*	Sl*	Sl*	Sl*	Sl*	Full	Mod-erate	Full	Mod-erate	Mod-erate	Mod-erate+	Moderate to full
Ewe death loss, %	4	4	14	12	9	4	8	5	6	8	12	0	2	6
Lambs born alive, % ewes bred	126	135	104	119	122	122	121	116	122	114	117	128	129	121
Lambs weaned, % ewes bred	83	85	92	69	105	95	88	83	82	102	69	118	98	92
Weaning weight, single, lb.	74	77	87	88	96	86	85	73	71	84	79	96	83	81
Weaning weight, twin, lb.	64	57	69	69	76	72	68	58	59	70	66	78	74	68
Lamb weaned, lb./ewe bred	59	58	73	57	91	76	69	58	54	80	53	104	77	71
Fleece weight, grease, lb.	8.6	9.3	9.0	9.3	10.5	9.6	9.4	9.1	10.0	9.6	9.5	10.7	9.6	9.8

*Sl. = slight

Table 5. Stocking rate, degree of use, ewe death loss, fleece and lamb production by years in the heavy continuously grazed and in the moderate rest rotation pastures. Antelope Range 1964-69.

Grazing system	Continuous							Rest Rotation						
Grazing rate	Heavy							Moderate						
Year	64	65	66	67	68	69	All years	64	65	66	67	68	69	All years
Stocking rate, AUMs/acre	.48	.55	.52	.47	.58	.51	.52	.29	.34	.32	.28	.36	.33	.32
Degree of use	Close	Full-	Close	Full	Full	Full	Full-Close	Mod-erate	Slight	Mod-erate+	Mod-erate+	Mod-erate	Mod-erate	Mod-erate
Ewe death loss, %	9	5	14	12	4	3	8	7	7	10	7	7	4	7
Lambs born, % ewes bred	109	119	106	107	136	118	116	109	105	96	116	133	118	113
Lambs weaned, % ewes bred	82	88	101	68	125	92	93	79	83	89	77	119	99	91
Weaning weight, singles, lb.	73	78	83	80	95	84	82	71	77	81	79	90	76	79
Weaning weight, twins, lb.	61	65	71	64	76	64	67	54	59	66	62	73	62	63
Lamb weaned, lb./ewe bred	57	66	79	53	105	68	71	54	52	67	57	96	70	66
Fleece weight, grease, lb.	8.4	9.3	8.8	9.0	10.4	9.2	9.2	8.2	9.0	8.6	8.9	10.3	9.0	9.0